THE SPLEEN AND DIGESTION.

Study III. The Spleen in Inanition; The Effect of the Removal of the External Secretion of the Pancreas on the Spleen.*

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The spleen atrophies in inanition. Some observers have believed this to bespeak a part for the spleen to play in the temporary storing of protein food materials, analogous, in a way, to the part played by the liver in the storage of glycogen.

A functional interrelationship between the spleen and the pancreas, asserting itself especially during the digestive period, has been believed to exist by many investigators. This idea has found chief expression in the theory first put forward by Schiff, in 1862, and later championed by Herzen, that the spleen forms a product of internal secretion which can change trypsinogen into trypsin.

A striking simple atrophy of the spleen following complete removal of the external secretion of the pancreas has recently been reported by Sweet and Ellis. This atrophy, they believe, is greater than can be explained by the loss in body weight occurring under such circumstances. If this be true, it has direct bearing on the part of the spleen in digestion, and is suggestive of a specific pancreatic splenic interrelationship.

The investigation of the Schiff-Herzen hypothesis by determining the influence of splenectomy on pancreatic secretion has been reported in Study II of this series. In the present study further data on the splenic atrophy occurring in inanition will be presented, and the question of a suggested influence of the pancreas on the spleen will be approached by a repetition of the observations of Sweet and Ellis.

The spleen is an unusually variable organ. Its normal size in different animals is markedly fluctuant. Its weight in proportion to body weight varies not only in genera and species, but also in the individual. It changes its volume on slight provocation, and is highly susceptible to hypertrophy and atrophy. Therefore, conclusions drawn from changes in the size of this organ must be carefully checked.

In death from starvation the body weight of mammals is reduced two-tenths to four-tenths in the young and four-tenths to

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five-tenths in the adult (Fredericq and Nuel). The percentage losses of various tissues and organs in the cat are: fat, 97 per cent; spleen, 66.7 per cent; liver, 53.7 per cent; muscles, 30.5 per cent; blood, 27 per cent; intestines, lungs and pancreas, 17 per cent; bone, 13 per cent; central nervous system, 3.2 per cent; and heart, 2 per cent (Voit).

The effects of inanition in albino rats have been studied exhaustively by Jackson. He found apparently a decrease in weight of the spleen of 51 per cent in acute inanition and of 29 per cent in chronic inanition. He states, "That the spleen loses heavily during inanition, losing in relative as well as absolute weight has been found in man (Aschoff'll; Stschorstuy, 1898), pigeon (Chossat, '43), rabbit (Bowin, '90), and cat (Voit, '66; Sedlinair, '99), while a decrease less marked than in the whole body (relative increase) appears in the dog (Falck, '54) and in thin steers, compared with fat (data from Missouri Agricultural Experiment Station). Data from von Bechterew ('95) indicate a relative increase in the spleen of newborn kittens during inanition, but a decrease in puppies. These apparently conflicting statements are perhaps to be explained largely by the great variability of the spleen, making comparisons with controls uncertain. In addition, however, there is the possibility that the loss in the spleen may vary according to the character and stage of inanition. Thus Sasarew ('97) in the guinea pig found the greatest loss in weight of the spleen to occur in the middle period of inanition (second period of 10 per cent loss in body weight)."

An interesting necropsy on a tailor who refused all food and died on the sixty-third day has been reported by Mayers. The spleen was small and shrunken with a wrinkled capsule; it was pale and flabby and weighed only 53 gm. The body weight at death was about 80 pounds; he had lost 40.7 per cent of his original weight. If the spleen normally was of average weight it must have given up excessively of its substance. Microscopic examination of the organ revealed almost complete absence of the corpuscles, the distribution of many erythrocytes around the parenchyma and little evidence of the presence of the splenic sinuses.

The histologic changes occurring in the spleen of the cat and of the guinea pig in acute starvation have been studied by Jolly and Levin. They found a thinning of the pulp cords and a reduction in the number of lymphocytes. The venous sinuses were often filled with large phagocytic cells stuffed with erythrocytes.

The observation that an excessive shrinkage of the spleen occurs when the external function of the pancreas is removed was reported in a brief communication by Sweet and Ellis in 1915. They resected the duodenal portion of the pancreas in dogs, or ligated the pancreatic ducts, or cut them with the interposition of omentum between the gland and the gut. Thus the internal function of the

pancreas was still provided for and glycosuria did not develop.. The animals had voluminous fatty stools, and at first lost weight rapidly; however, after several months they reached a stationary weight or even gained slightly. The change noted in the spleen consisted apparently of a simple atrophy, and was marked after three days. Control experiments in animals with equal loss of weight were not performed.

Sweet has suggested that there may be a possible surgical bearing of this relation between the pancreas and the spleen. He cites the report of Musser of an acute anemia in four of eight cases of acute pancreatitis. In view of the generally accepted relation of the spleen to the blood, he considers his finding of an acute splenic atrophy under the conditions citied as suggestive of an explanation of Musser's report of acute anemia, and as furthermore suggestive of the importance of clinically following the blood picture in cases of suspected or proved acute pancreatitis.

Animals deprived of sustenance are obliged to draw on their own storehouses and their own tissues for food. Yet dearth of aliment not alone leads to inanition, for non-assimilation, even though food is taken in the greatest of plenty, attains a similar end. If pancreatic juice is excluded from the intestine there is a marked diminution in the absorption of nitrogen and fat, as has been demonstrated by Pratt, Lamson and Marks. This results in an immediate disturbance in metabolism with loss in body weight. May not then the dwindling of the spleen in animals in which the external function of the pancreas has been removed be merely the expression of the ease with which this organ gives excessively of its substance when the body labors under nutritional deficiency? May it not be merely the atrophy of the spleen of inanition?

Most comparative studies of the changes in weight of organs have been made by checking the findings of the abnormal states with the findings under normal conditions in individuals of the same species. In the case of the spleen this method is fraught with great error attributable to the protein habits of this most mysterious and changeable organ. Hence, in the gathering of experimental data in answer to the above question complete observations should be made on one and the same animal in each instance.

Experimental Methods and Data.—In adult dogs complete removal of the external secretion of the pancreas was obtained by resection of the duodenal portion of the gland with tying off securely the severed ends of the remaining pancreas after the manner of Sweet and Ellis or by double ligation of the pancreatic ducts. Observations were also made on dogs with pancreatic fistulas complicated in most cases by pancreatitis. These animals were kept on full diet. As controls, dogs were fed a half-day's ration every third day and fasted in the interval. The size of the spleen was determined

at the start and at the end of every experiment. Microscopic sections of the spleen and pancreas, and often also of other organs, were made.

The initial splenic weight was determined as follows: Measurements of the total length, of the width of the head and of the tail, and of the thickness of the spleen were made by a movable centimeter scale. For the head the measurement of greatest width was taken; for the tail a transverse line was drawn through a point on the longitudinal axis of the organ (this point was placed at such a distance from the caudal extremity as to represent a certain fraction of the total length of the spleen); and for the thickness, a line was drawn at the middle of the gland running from the hilus perpendicularly to the broad free splenic surface.

The body, and thus the major portion of the spleen of the dog, most nearly resembles a rectangle in outline; the head is increased in width at one side and tapers at the tail; a cross-section at most points is triangular with the apex at the hilus. Therefore, because of its form, the exact computation of the volume of the spleen is not feasible from the measurements taken. However, since weight, the final value of which is easily determined at necropsy, serves our purpose even better than volume, the use of proportion will permit us to make an approximate estimation of the initial weight of the spleen without knowing the exact splenic volumes.

If changes in specific gravity are disregarded for the time being the proportion as follows will hold: $x : a :: y : z$. (in which x = initial splenic weight, a = final splenic weight, y = initial splenic volume and z = final splenic volume).* Since the splenic volumes are unknown as well as the value of x, we may substitute for y and z in the proportion the volumes of similar rectangular parallelopipeds (for the volumes of similar irregular solids are proportional to the similar regular parallelopipeds most nearly approximating their own shape) which can be determined from the measurements given. In the present study the lengths and thicknesses of the spleens and the means of the widths of their heads and tails have been taken for the dimensions of the parallelopipeds. If then b is taken as the volume of the parallelopiped corresponding to the initial size of the spleen and c as that corresponding to the final size, these known values may be substituted for y and z in our proportion, which will then read: $x : a :: b : c$.

However, the values thus determined for x do not take into account changes in specific gravity. In three of the spleens in this series the specific gravity (determined by Hammerschlag's method) was found to be approximately 1.060 for the normal and 1.070 in inanition. There were but small changes from this latter figure with lesser or greater lengths in the periods of loss of weight,

* The author is indebted to Mr. H. O. Stearns of the Mayo Clinic for suggestions regarding the mathematical procedure used in this method.

the spleen evidently losing very rapidly of its fluids in acute inanition. Therefore in the values given for the initial weights of the spleens this correction for change in specific gravity has been made, that is, the initial weights have been multiplied by the factor 0.99.

Histologic Changes.—*The Spleen.* The histologic changes in the spleen, found in these experiments, appeared similar, regardless of the procedure employed, so long as loss of body weight occurred. In the instances in which the experiments were prolonged for fifty days or longer the microscopic picture seemed identical in the fasting animal and in the animal deprived of the external secretion of the pancreas. Therefore the histologic findings will be given in one description.

Changes in the spleen were observed as follows: The capsule was shrunken, wrinkled and much decreased in width; its fibrous tissue strands were compact, giving at times an almost hyaline appearance; nuclei were less abundant and the few scattered lymphocytes usually seen were absent. The shrinkage in the splenic septa was not so noticeable. The parenchyma, however, was quite decreased in amount, so that comparatively the septa stood out as more numerous than normal. In the splenic pulp the cells often were packed almost as closely as in the normal Malpighian corpuscle. The tissue spaces were largely obliterated. The cytoplasm of the pulp cells and pulp supporting tissue had largely disappeared, and the nuclei, closely crowded, chiefly remained. The splenic sinuses, although diminished in size, often stood out clearly; the amount of blood they contained was less than that seen in a normal section. The number of lymphocytes outside the Malpighian corpuscles was markedly decreased; cells of large type predominated. The Malpighian corpuscles themselves and their germinal centers seemed more definitely delimited than usual. The larger bloodvessels of the gland appeared but little altered. There was constantly more free blood pigment in the pulp than normal.

The degree of these changes seen in the spleen was roughly proportional to the length of the experimental period and to the acuteness with which loss of body weight occurred. The changes themselves were such as those ascribed to a simple atrophy of the gland.

The Pancreas. In the instances in which a partial pancreatectomy was performed, or the pancreatic ducts were ligated, varying degrees of destruction of the pancreatic acini and their replacement by connective tissue occurred, depending on the length of time of removal of the external function of the pancreas with the resultant obstruction of the pancreatic ducts. In the most acute experiments merely a decrease in the clearness of the staining reactions or a beginning necrosis was seen. In the prolonged

experiments very little acinar tissue was left. The pancreatic ducts and their larger ramifications were in most instances dilated to three or four times their normal size.

In those cases in which pancreatic fistulas were performed without infection no damage to the acinar tissue occurred. However, generally a complicating purulent pancreatitis, of varying intensity and acuteness, was present.

Protocols.—All operative procedures on the experimental animals were performed under ether anesthesia with the employment of

FIG. 1.—D 537. Ligation of pancreatic ducts. Normal spleen at the beginning of the experiment. Photomicrograph × 50.

sterile technic. In none of the dogs in which the external function of the pancreas was removed did glycosuria appear; all, however, had fatty stools.

Ligation of Pancreatic Ducts.—D 537, a male mongrel in good condition. April 23, 1920, both pancreatic ducts were doubly ligated and divided. The animal gradually lost 2.6 kg. during the first month and then became stationary in weight till the ninth week, when symptoms of inanition appeared. From this time there was a rapid and progressive loss. July 27 the dog was killed

by etherization. At necropsy very little pancreatic tissue could be found. The pancreatic ducts were not dilated. Histologically the pancreas consisted almost entirely of connective tissue, although a few areas were still present containing islets of acinar tissue (Figs. 1, 2 and 3).

Resection of Duodenal Portion of Pancreas.—D 648, a male mongrel in good condition. April 30, 1920, the duodenal portion of the pancreas was resected. The animal made an excellent recovery and maintained its weight for one week. During the next three

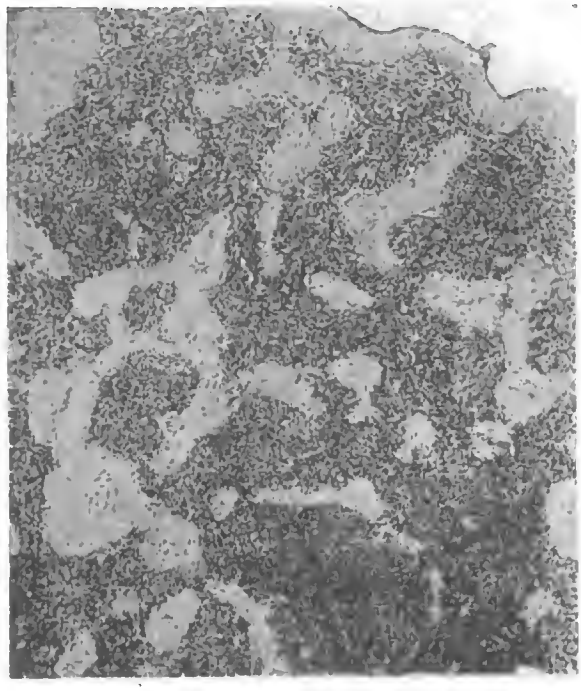

FIG. 2.—D 537. Ligation of pancreatic ducts. Spleen at the end of the experiment. Photomicrograph × 50.

weeks there was a loss of only 1 kg.; following this there was a progressive and steady decline in weight. July 22, the dog was killed by etherization. At necropsy all the tissues seemed to be anemic; save for a few small islets the pancreatic glandular tissue had disappeared. The pancreatic ducts were distended to about six times their normal size. It was difficult to identify the splenic sinuses histologically; they appeared almost obliterated. The pancreas was fibrous.

D 649, a male mongrel in good condition. April 30, 1920, the

duodenal portion of the pancreas was resected. The skin incision became infected and did not heal. Later, distemper developed. The dog lost weight rapidly and progressively from the time of the operation. It was killed by etherization May 17. At necropsy a diffuse pancreatic fat necrosis was found. Histologic examination revealed much free blood pigment in the spleen. The pancreas was necrotic. There were areas of bronchopneumonia in the lungs.

D 661, a male poodle in fair condition. May 7, 1920, the duodenal portion of the pancreas was resected. The animal recovered

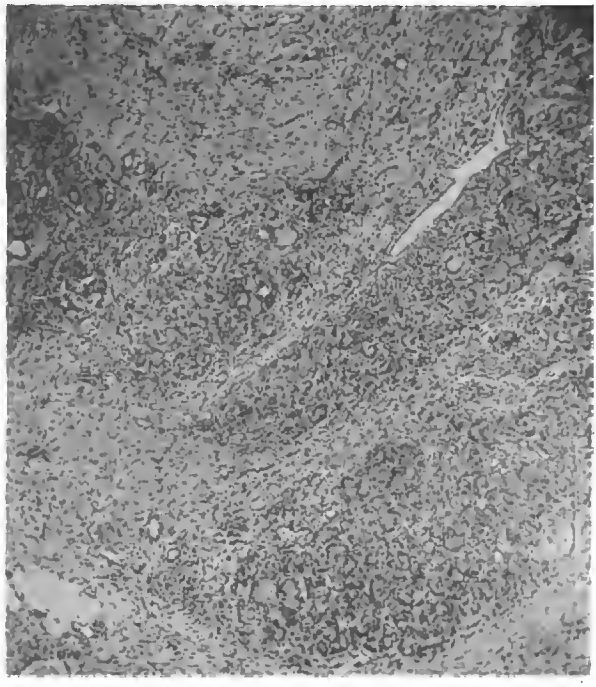

FIG. 3.—D 537. Ligation of the pancreatic ducts. Pancreas showing fibrosis and remaining islets of acinar tissue at the end of the experiment. Photomicrograph × 50.

well, but lost weight steadily until the last eleven days before death, when the weight became stationary. July 2, the dog was killed by etherization. At necropsy very little pancreatic tissue was found. The pancreatic ducts were dilated to about four times their normal size. The section of the spleen removed at operation for histologic study contained a number of large multinucleated cells. Only a few of these could be seen in the section from the specimen removed at necropsy. There was a marked collection of blood pigment in the pulp of the atrophic spleen. In the pancreas a small amount of acinar tissue was left in islets (Figs. 4 and 5).

D 698, a female terrier in good condition. May 27, 1920, the duodenal portion of the pancreas was resected. The spleen was large for the size of the dog and grossly pathologic; it was cirrhotic and contained numerous small infarcts. The animal developed distemper almost immediately and was killed by etherization May 31. At necropsy marked purulent conjunctivitis, rhinitis and tracheobronchitis were present. The abdominal wound was infected superficially and showed no evidence of healing. There was a slight degree of pancreatic fat necrosis in the omentum

FIG. 4.—D 661. Partial pancreatectomy with loss of external secretion of pancreas. Spleen at the end of the experiment. Photomicrograph × 50.

around the ends of the severed pancreas. The pancreas itself was indurated as if it had been in fixing fluid. There were no findings to explain the original pathologic condition of the spleen. Histologic examination did not reveal changes in the spleen or the pancreas.

Pancreatic Fistula Complicated by Infection.—D 720, a female mongrel in excellent condition. June 12, 1920, a one-stage operation for pancreatic fistula was performed. An accessory spleen 0.45 cm. in diameter was found in the omentum 7 cm. from the hilus of the major spleen. The animal refused all food, and milk fed

through the stomach tube was vomited. An irritative pancreatic secretion appeared and the animal thus continuously lost large quantities of pancreatic juice. The last four days preceding death, which occurred July 2, a marked inanition supervened. At necropsy a non-purulent infection involving the transplanted portion of the pancreas was found. A large amount of subcutaneous fat was still present, but the animal was extremely dehydrated. The accessory spleen was atrophic with a diameter of 0.34 cm., thus having lost 43 per cent in volume.

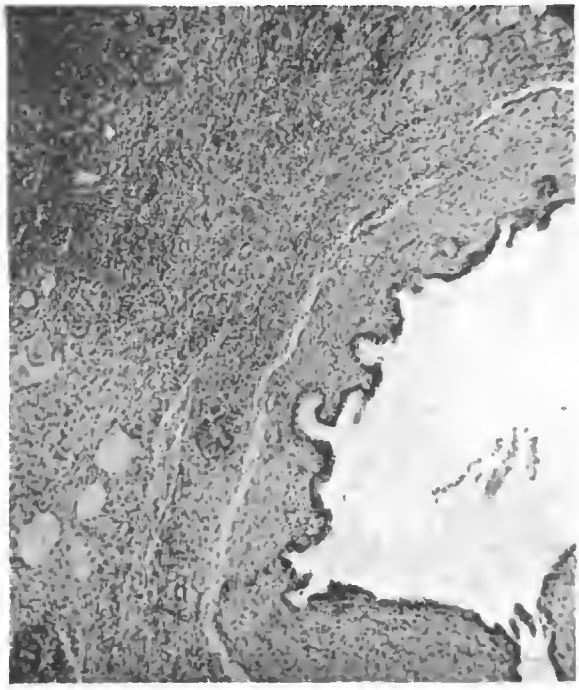

FIG. 5.—D 661. Partial pancreatectomy with loss of external secretion of the pancreas showing destruction of acinar tissue with fibrosis and a dilated pancreatic duct. Photomicrograph × 50.

D 743, a male bull terrier in fair condition. June 19, 1920, a one-stage operation for pancreatic fistula was performed, with ligation of the minor pancreatic duct. The wound became infected superficially and was slow in healing; the animal steadily lost weight and became extremely emaciated, and there was a marked continuous irritative secretion of juice from the fistula. The animal died July 14. At necropsy a purulent pancreatitis was found.

TABULATION

Animal.	Duration of experiment, days.	Initial body weight, kg.	Final body weight, kg.	Total change in weight, kg.	Length of spleen, cm.		Width of spleen, cm.				Thickness of spleen, cm.		Initial weight of spleen (approximate), gm.	Final weight of spleen, gm.	Spleen: initial percentage of body weight (approximate).	Spleen: final percentage of body weight.	Percentage of change of body weight.	Percentage of change of weight of spleen. (approximate).	Procedure.
							Head.		Tail.										
					Initial.	Final.	Initial.	Final.	Initial.	Final.	Initial.	Final.							
D 698	4	9.5	8.5	−1.0	15.8	13.8	4.1	3.3	3.5	3.3	1.3	1.2	52.3	37.0	0.550	0.435	−10.5	−29.8	Partial resection of pancreas (distemper).
E 129	4	19.6	16.8	−2.8	16.0	15.5	7.1	4.6	4.0	3.3	1.3	0.8	73.2	32.6	0.373	0.194	−14.3	−55.5	Pancreatic fistula (peritonitis).
E 131	15	10.0	7.6	−2.4	14.2	14.2	5.3	4.0	4.0	2.3	0.8	0.7	30.5	18.3	0.305	0.240	−24.0	−40.0	Pancreatic fistula (pancreatitis).
D 649	17	7.0	4.8	−2.2	11.1	10.6	3.1	2.6	2.6	2.1	0.7	0.4	14.5	8.0	0.207	0.166	−31.3	−45.0	Partial resection of pancreas (pancreatic fat necrosis; distemper).
D 730	20	11.7	8.2	−3.5	10.9	9.8	3.8	2.1	2.9	1.8	1.1	0.6	29.0	8.5	0.248	0.104	−29.9	−70.7	Pancreatic fistula (pancreatitis).
D 743	25	19.6	12.4	−7.2	17.6	15.8	6.1	4.5	4.0	2.8	1.4	1.1	72.3	33.8	0.369	0.273	−36.7	−53.0	Pancreatic fistula; ligation of minor pancreatic duct (pancreatitis).
D 130	28	10.2	10.6	+0.4	13.8	15.2	4.8	4.6	4.0	3.4	1.0	1.0	28.47	28.5	0.279	0.269	+ 3.9	+ 0.1	Pancreatic fistula.
D 876	51	9.4	6.4	−3.0	11.9	9.8	5.9	4.0	2.0	1.7	0.8	0.6	20.0	10.0	0.213	0.156	−31.9	−60.0	Fasting.
D 875	51	13.0	7.0	−6.0	11.7	8.0	6.7	4.3	2.5	1.6	2.2	0.7	56.4	7.8	0.433	0.111	−46.2	−86.1	Fasting.
D 661	55	13.8	7.8	−6.0	17.0	10.4	4.5	2.3	4.0	2.0	1.4	0.7	70.0	10.5	0.508	0.350	−43.5	−85.0	Partial resection of pancreas.
D 648	82	14.1	8.6	−5.5	11.4	8.6	5.2	4.5	3.1	2.1	1.0	0.5	29.7	9.0	0.248	0.105	−39.0	−70.0	Partial resection of pancreas.
D 537	96	17.6	9.7	−7.9	14.1	11.4	4.8	3.0	4.4	2.4	1.0	0.8	40.5	16.0	0.287	0.165	−44.5	−60.5	Ligation of pancreatic ducts.

E 131, a male mongrel in good condition. December 7, 1920, a one-stage operation for pancreatic fistula was performed. The wound became infected and a continuous irritative secretion of pancreatic juice appeared. The animal refused food and lost weight rapidly. Death occurred December 22. Pancreatitis was found at necropsy. The initial specific gravity of the spleen in this instance was 1.061, that at death 1.073.

E 129, a male shepherd in good condition. December 7, 1920, a one-stage operation for pancreatic fistula was performed. The

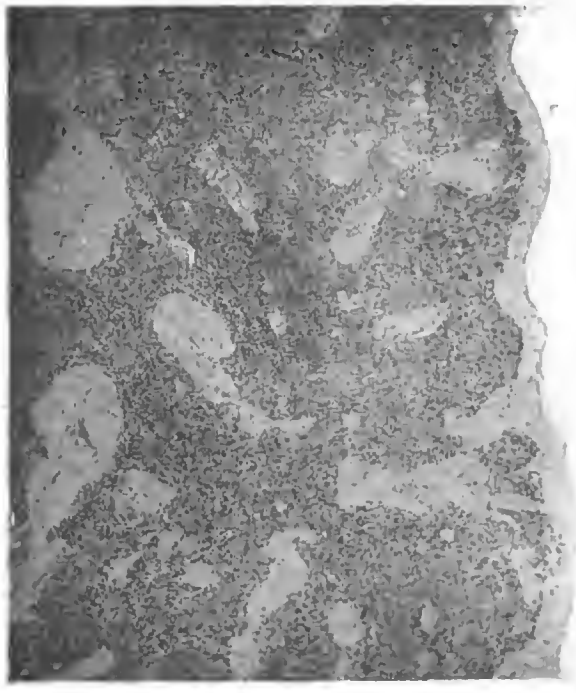

FIG. 6.—D 875. Fasting. Spleen at the end of the experiment. Photomicrograph × 50.

animal became extremely ill and died December 11. At necropsy a generalized peritonitis with a small amount of sanguinopurulent fluid in the peritoneal cavity was present. The initial specific gravity of the spleen in this instance was 1.062; that at death, 1.070.

Fasting.—D 875, a male bull terrier in good condition. August 6, 1920, the abdomen was opened and measurements of the spleen taken. The animal was then fed a half-ration every third day and fasted in the interval. Save for a slight gain at the end of one and a half weeks and a stationary period from the seventeenth to the twenty-sixth day the animal lost weight progressively. September

28, splenectomy was performed. Death occurred two days later, probably as a result of the operation and the dog's weakened condition. A section of the spleen at the first operation had many multinucleated giant cells, and free blood pigment was present in the pulp. A section of the spleen at its removal showed changes identical with those occurring after removal of the external secretion of the pancreas. The amount of free blood pigment was increased. No multinucleated giant cells could be found (Fig. 6).

D 876, a male mongrel in good condition. August 8, 1920, the abdomen was opened and the spleen measured. The animal was then fasted in a manner similar to D 875. The weight from the twelfth to the twenty-sixth day remained constant, but steadily decreased at all other periods. September 28, splenectomy was performed. The dog made a good recovery. The histologic changes in the spleen were those of a simple atrophy.

Uncomplicated Pancreatic Fistula.—E 130, a female mongrel in good condition. December 7, 1920, a one-stage operation for pancreatic fistula was performed. Recovery was excellent and the wound healed without infection. Secretion of juice from the fistula was normal. The animal was carefully fed and gained weight slightly. January 4, 1921, the spleen was removed, without incident. The initial specific gravity of the spleen was 1.061; that at the time of splenectomy was 1.060. The splenic measurements remained practically the same.

Discussion.—The size of the spleen of the dog varies greatly; in this series of experiments it fluctuated between 0.2 and 0.55 per cent of the body weight, with an average of about 0.3 per cent.

The data submitted justify the conclusion that the spleen loses markedly in weight in inanition and are in general corroborative of the findings of other investigators. The loss in the weight of the spleen is out of all proportion to the decrease in body weight, being almost three times as great as a maximum in extreme cases of acute inanition, and approximately twice as great in cases of less acute.

The removal of the external function of the pancreas by ligation of the pancreatic ducts or resection of the duodenal portion of the gland likewise leads to an excessive decrease in the size of the spleen. This finding thus confirms the observations of Sweet and Ellis. However, the shrinkage of the spleen under these conditions can be explained as due to the inanition resulting from the exclusion of the pancreatic juice from the intestine, and does not require for its elucidation the postulation of a specific pancreatic splenic interrelationship.

The loss of weight of the spleen in relation to the loss of body weight in these experiments is shown graphically in Figure 7. It will be noted that the greatest loss of weight both of the body and of the spleen occurs within the first month. The diminution of

the weight of the spleen is especially rapid during the first few days of inanition. The chart indicates also how markedly the percentage splenic weight fluctuates from the normal in contradistinction to the percentage body weight, which shows relatively little such fluctuation.

That the marked atrophy of the spleen under the experimental conditions of this study is nothing more than the mere expression of the disproportionate share of the gland in the general loss of weight is shown by a comparison of the experimental results in the cases of Dogs D 661 and D 875, the former representing a

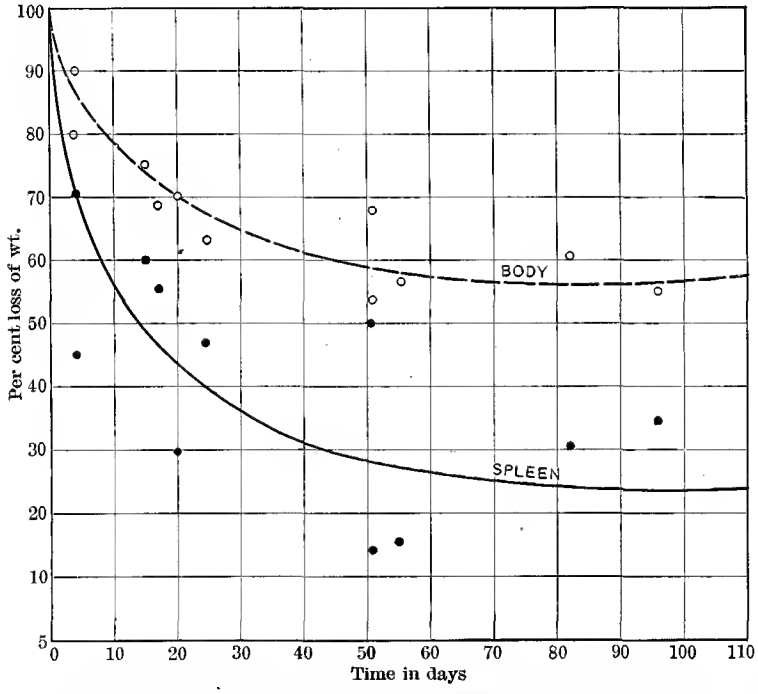

FIG. 7.—Graphs illustrating the percentages of losses of weight of the body and of the spleen in relation to the length of the inanition period. (See table.)

partially pancreatectomized animal and the latter a control under starvation. Both animals weighed approximately 13 kg. and lost about 45 per cent of their body weight within a period of fifty days, whereas their spleens each lost about 85 per cent of their original weight. These are the most marked losses in weight obtained, but the experiments are in every sense parallel (Fig. 8).

The observations made on Dog E 130, with a pancreatic fistula, show that even if an animal loses over half the amount of pancreatic juice secreted and yet maintains a stationary body weight there is no loss in the size of the spleen.

Data were collected on dogs with pancreatic fistulas complicated by infection in order to study the effects of pancreatitis on the spleen, since Sweet has suggested that in this direction may be the explanation of the anemia of pancreatitis found in certain cases by Musser. Save for a more acute and marked loss in weight of the animals, caused doubtless by the toxemia of the infection and by the dehydration and loss of alkali resulting from the constant secretion of large quantities of juice from the fistula, the results obtained in these cases seem entirely comparable with those obtained in the cases of fasting and removal of the external secretion of the pancreas.

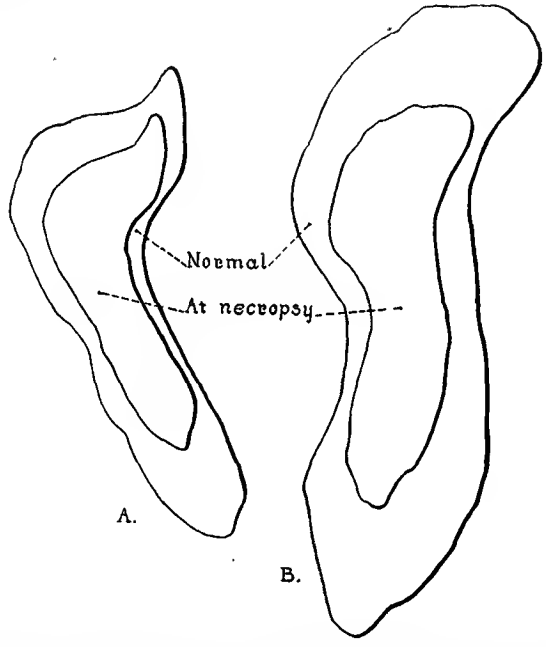

FIG. 8.—Marked shrinkage of the spleen. *A*, in fasting (D 875); *B*, following partial pancreatectomy with loss of external secretion of pancreas (D 661).

It might be expected that in acute infections, for example, the cases of acute pancreatitis, of distemper, and of peritonitis, given in the protocols the toxemia would cause enlargement of the spleen in the form of acute splenic tumor. Yet in these infections the animals refuse food and assimilate poorly what is taken. Marked loss of weight develops and, as shown in these experiments, the spleen diminishes in size.

Of what significance is this extraordinary atrophy of the spleen in inanition? Why must this organ, next to the inert tissue, fat, give so readily and lavishly of its substance for the nourishment of its host? Does such lavishness imply that this unique gland

can play but a slightly important part in the general economy and physiology of the organism; or may it still be that the spleen can give heavily of its substance in famine and yet remain a valuable organ with divers and sundry useful though little known functions? Or does the spleen with specific purpose aid in the garnering and temporary storing of protein food materials in order that it may dole out sustenance when the body is hard put?

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GASTROSPASM: A CLINICAL AND ROENTGENOLOGICAL STUDY.[1]

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Even before the roentgen-ray era local gastrospasm, especially such that occurs at the entrance and exit of the stomach (cardio-

[1] Read in part by J. Roemer, M.D., at the annual meeting of the New Jersey State Medical Society, June 15, 1920.